XXI. *On the distribution of the* Charlonia *group of the genus* Anthocharis. By George T. Baker, F.L.S.

[Read September 4th, 1889.]

This small division of desert species of the genus *Anthocharis*, forming a very natural and closely allied group, presents many points of interest, both in their relationship to each other and in their geographical distribution. They are only six in number, but range from the Canaries on the west to the Valley of the Indus in the east, and though found in such places as Lambessa in Algeria, and Malatia in Armenia, cannot be considered as otherwise than desert insects, being always found in the vicinity of country having either desert or semi-desert characteristics. They form of themselves two natural subgroups, *viz.*, white and yellow, the species of which I will tabulate and describe thus:—

Yellow.	White.
Charlonia, Donzel. Algeria; Tunis; Fortaventura.	*Penia*, Frr. Asia Minor; Caspian district.
Var. *Mesopotamica*, Stgr. Malatia (Asia Minor).	*Tomyris*, Chr. Askhabad.
Lucilla, Butler. India (N.W. Punjab).	*Pechi*, Stgr. Algeria.

Charlonia, Donz.

The fore wings are pale lemon-yellow, with the blackish discoidal spot of an irregular quadrangular shape. The apical patch varies in hue from brownish to almost black, likewise in extent; it is of a somewhat hollowed (internally) triangular shape, with the usual transverse spotted band more or less developed; costa pinkish, with rosy fringes. The hind wings are of the same lemon hue, but with the dark greenish under side showing through. Fringes whitish. Base of all the wings dark grey. Beneath the fore wings are pale yellowish, with the discoidal spot smaller and reniform in shape. The apical patch is greenish yellow, of the same shape and dimensions as the upper surface. Costa and fringes

rosy, the hinder third of the former being dotted with very pale lemon. The hind wings are greenish, very finely and densely irrorated all over with grey, and spotted more or less markedly on the posterior margin with whitish, with a small central whitish spot, between which and the anal angle are two more whitish dots close together. My smallest specimen measures 28 mm. in expanse, and the largest 37 mm.

I have two ♀ ♀ which differ in no way whatever from the ♂, and I learn that the two sexes are precisely similar.

This species was first described and figured by Donzel in the 'Annales Soc. de France,' 1842, pp. 197, 198, pl. 8, fig. 1; also, under the name *Levaillantii*, by Lucas in the same work, 1847, pp. xlix and l; and in 1850, p. 92, pl. 2. This same author again described it in detail and figured it in the 'Exploration de l'Algérie,' pp. 348, 349, pl. 2, fig. 1. The characteristics on which he relies for the separation of his *Levaillantii* from Donzel's *Charlonia* will not, however, hold good, *viz.*, the pink costa, the larger apical patch, and the discoidal spot being surmounted by another small spot between it and the costa. These points are extremely variable, and in a large series it would be quite impossible to separate them, so that they are certainly insufficient to permit of even a varietal name. Mons. Oberthür assures me that Donzel's and Lucas's insects are one and the same species. *Levaillantii* must therefore sink as a synonym of *Charlonia*, Donz. It is by no means uncommon in Algeria, has occurred in Tunis, and quite recently two perfectly typical specimens have been sent to the National Collection from Fortaventura in the Canaries.

Var. *Mesopotamica*, Stgr.

The difference between the upper side of this and *Charlonia* is slight; the discoidal spot is less angled, whilst the apical patch is more extended along the posterior margin towards the anal angle. The fore wings are, however, decidedly rounder in shape, this being caused by the costa being somewhat deflexed posteriorly just in front of the apex. On the under surface the difference is more marked; the fore wings are yellower, and the discoidal spot absent, this spot on the upper surface only showing through very indistinctly; the apical patch is pale greenish yellow, densely irrorated with grey. The hind wings are pale yellowish green,

densely irrorated with light grey; they are decidedly paler than in *Charlonia*, and much less spotted than in that species. *Mesopotamica* is also a larger insect than Donzel's species, measuring from 36 to 44 mm.

This variety is as yet only recorded from Armenia; my specimens were all taken at Malatia.

Lucilla, Butl.

♂. Fore wings pale gamboge-yellow, the blackish-brown discoidal spot large, with the dark apical patch extending more than three-quarters down the posterior margin, and angled interiorly in the same manner as *Penia*, the spotted transverse band herein being more or less distinctly marked. Costa and fringes pink. Hind wings same colour as fore wings, the base of all being blackish. Beneath the fore wings are decidedly paler yellow, and the discoidal spot is smaller than above, with the apical patch showing through as a dark dusting, of the same shape as on the upper surface. The hind wings are also paler yellow, with only a very slight dusting indeed of dark scales on the posterior margin; the central white spot and spotted margin as in *Charlonia*. This description is taken from Butler's type, but from the series now in the National Collection, numbering in all fourteen ♂ ♂ and ♀ ♀, it may be well to add somewhat respecting the under surface to it; the apical patch is sometimes more darkly dusted than the type, and also the hind wings occasionally approach near to the hue of *Charlonia* in being finely irrorated with grey, giving them the colour of yellowish grey, instead of the very decided yellow of the type.

♀. The fore wings of ♀ are very pale whitish sulphur, with the blackish discoidal spot very large indeed, extending right down to the inner margin of the cell, being broad in proportion, and of a roughly quadrangular shape; the blackish apical patch is also very large, angled as in ♂, and extending broadly even lower down the posterior margin than in that sex, with only just a trace of the transverse spotted band. Hind wings yellow, with the least trace of a greenish tinge, and with a broad border of dark dusting all round the posterior margin. Beneath the ♀ differs in no way whatever from the ♂, even the discoidal spot being no larger, though so large on the upper surface.

The females in the National Collection are very interesting, as they vary much in coloration, one being almost quite white, whereas the extreme in the opposite direction is very yellow.

This species is a close ally of *Charlonia*, but the whitish ♀ at once separates it, together with the very large discoidal spot and apical patch; in the ♂ also these two latter characters are decidedly larger than in *Charlonia*, and the under surface of the hind wings is often quite yellow, and when irrorated with grey is never nearly as dark as in Donzel's insect.

All the fourteen examples in the National Collection were sent from the same neighbourhood, *viz.*, Campbellpore, Attack Bridge, Akhor, and Khairabad, the earliest specimen being labelled April 18th, 1886, and the latest June 27th, 1886.

The whitish ♀ is of great importance in our study of this small group, in pointing out which of the two forms, the white or the yellow, is in all probability the ancestral species.

Penia, Frr.

This species is—of the white group—the most nearly allied to *Charlonia*. It is of a whitish colour, slightly tinged with pale sulphur. The discoidal spot is brown, and in shape is a regular quadrangle. The apical patch is greyish brown, deeply and obtusely angled, extending fully three-quarters down the posterior margin; the spotted transverse band is angled in like manner. The hind wings are more sulphurous, and exhibit the dark under side through. Both wings are slightly greyish at the base. Costa pink. Fringes greyish at apex, tinged with pink at anal angle. Beneath the fore wings are whitish, tinged with sulphur on the costal half, with the discoidal spot smaller, scarcely extending beyond the costal margin of the cell. The apical patch is pale greenish yellow, closely and finely irrorated with grey; the costa and fringes pinkish, the former very lightly dotted within the apical area. The hind wings are yellowish green, finely irrorated with pale grey; the central whitish dot is small, sometimes rather indistinct; the posterior margin is slightly spotted; and there is scarcely more than a trace of the two spots between the central spot and the anal angle.

This species was first described by Freyer in his 'Neue Beiträge,' vi., p. 149, pl. 574, from a single broken specimen without name or locality; it was subsequently found by Staudinger at Malatia, and by Christoph in N. Persia and Turkestan, and I have specimens from Krasnovodsk, on the Caspian; so that it probably ranges all through Northern Asia Minor and

Persia up to the edge of the Khivan Desert. I would draw your attention to the fact of its occurrence at Malatia, as we see here the whitish *Penia* and yellow var. *Mesopotamica* overlapping each other.

Anthocharis Tomyris, Chr.

♂. The fore wings are white, with a pale sulphurous tinge; the discoidal spot is reduced to a minimum, and is triangular in shape, the base thereof being angled inwards. The costa is broadly greyish from the disco-cellular vein to the margin, extending from the base of wing to the discal spot; the apical patch is pale greenish grey, much reduced in size, and extending further along the costa than down the posterior margin, with no trace of the transverse band, but there are four small yellowish dots on the costa within this area. Costa pale pinkish; fringes slightly tinged with pink. The hind wings are rather yellower in colour than the fore wings, showing the dark under side through, and also exhibiting through the single whitish central spot of the under surface. The roots of all the wings are blackish. Beneath the fore wings are paler than above, with the greyish discal spot smaller. The apical area is yellowish green, finely irrorated with brownish grey. The hind wings are greenish, very finely irrorated with brownish grey, with a single whitish dot in the centre, on the posterior margin of the median cell.

♀. This sex is quite remarkable in the pattern of its fore wings, which are sulphurous greyish white, with the dark grey discoidal spot very large, roughly quadrangular, and extending nearly half across the wing, and right up to the costa, from whence to the roots the costa is broadly bordered with grey. The apical patch is dark grey, large, extending broadly right down the posterior margin almost to the anal angle, which angle is dusted with dark scales extending upwards and connecting the dark margin therewith. The whole of the inner margin is likewise more or less dusted with dark scales. The costa is finely pinkish. Hind wings greyish sulphurous yellow, slightly dusted with dark scales, which are particularly noticeable round the posterior margin and along the inner edge of the median cell. Fringes of both wings slightly rosy. Beneath the fore wings are whiter than above, the discal spot showing through almost as large as above; the costa is grey from this spot to the base, and has an internal broad border of yellow, which is continued up to the apical area; this apical patch follows the shape of the upper surface very closely, but is yellowish, finely and densely irrorated with brownish grey, the irrorations

becoming less close down the posterior margin to the anal angle. The hind wings are yellowish green, very finely irrorated with brownish grey, with the single central whitish spot as in the ♂. In both sexes the wings are somewhat rounder than any of its near allies, this being specially noticeable in the ♀. ♂ 43 mm., ♀ 39 mm.

This beautiful species was described and figured by Christoph in vol. i., p. 99, pl. vi., fig. 1, of those finely-executed Memoirs by the Grand Duke Romanoff. It has only hitherto been recorded from Askhabad, and is the largest of the group, the two specimens before me measuring, ♂ 43, ♀ 39 mm., the ♂, contrary to the rule, being the larger of the two. Christoph gives 22 mm. as his measurement; this must refer to the one wing, not the alar. expanse usually meant.

Anthocharis Pechi, Stgr.

Anterior wings white, with the discoidal spot grey, and of an irregular quadrangle in shape; the apical patch is also grey, with a small indistinct whitish spot just in front of the apex. The costa is broadly greyish from the discal spot to the base; base of all wings blackish. The posterior wings are whitish, the dark under side showing somewhat through. Beneath the apex of the anterior wings is greenish yellow, finely irrorated with dark grey; the discoidal spot, which appears through but faintly, is pale grey, with a whitish crescent therein. The posterior wings are greenish yellow, more intensely irrorated with grey, and having the single small whitish spot in the centre. The collar is pale lemon-colour; antennæ grey tipped with lemon. Fringes white, greyish at apex. ♂, 32—33 mm.; ♀, 36 mm.

This interesting species was first taken by Wilhelm Pech, of Budapest, at Lambessa, in April, 1884, and was described by me in the Ent. Mo. Mag., vol. xxi., p. 241. My friend Dr. Staudinger, however, likewise published a description (under the same name), which, owing to a little misunderstanding, appeared somewhat earlier in the 'Ent. Nachrichten'; hence the two descriptions appearing so close together.

This insect can be recognised at a glance from any of its predecessors; the apex is more acute, and the posterior margin straighter; it is also much whiter than either *Penia* or *Tomyris*. As yet it has only been taken at Lambessa, where it appears to be very rare, as it has, I believe, only been taken in 1884, when M. Oberthür's

collector took it at the same time as Pech did. Dr. Staudinger did not find it during his expedition there the year before last.

The distribution of the several species is therefore—Yellow Group: N.W. India; Armenia; Algeria; Canary Isles. White Group: Askhabad; Turkestan; N. Persia to Armenia and Algeria.

Consequently Armenia and Algeria are overlapping areas. This discontinuity is very peculiar, and I will therefore review all the data which I have been able to obtain, and see how it can be accounted for.

We find both the white and yellow forms inhabit the same line of country, the most distinct species being found furthest east and west, both being yellow; whilst the two very distinct white species, *Tomyris* and *Pechi*, are likewise found to obtain within a limited area almost as far from each other as their yellow allies. The varieties taken in the intervening localities are in each instance a sort of connecting-link between the extreme forms.

To obtain the desired evidence it is necessary to go back to the early Tertiary times, and see what Geology teaches us. At this period a tropical or subtropical climate extended from the Pole to the Tropic of Cancer with but little variation. The temperature then began to decline gradually, till it culminated in the Glacial Epoch, with which the Quaternary Era opens; this refrigeration was followed by a secular increase of temperature, which is supposed to have continued with comparatively unimportant variation to the present day.

We must now look to the fauna of those days for assistance, the Mammalia of which will be sufficient for our present purpose.

In a gravel-bed near Madrid the remains of the striped hyæna and elephant, both African animals, have been discovered. The bone-caves of Gibraltar have yielded many species, such as the lion, lynx, spotted hyæna, and serval, the two latter being now only found in Africa. The Sicilian bone-caves have also yielded the elephant, lion, and spotted hyæna.

The hippopotamus (*H. major*) lived in England, France, Spain, Sicily, Italy, and Africa; whilst, curiously, an extinct South European elephant (*E. meridionalis*) has

been found in Algeria, whither it must have travelled from S. Europe.*

Now of the northern Mammalia, the mammoth is the only one recorded from Spain; it also existed in parts of France and Northern Italy (range not definitely known),† but in the caves of Perigord and others in Central France the bones of the reindeer and musk-sheep, as well as the mammoth, have been discovered.

From all these facts we must conclude that in the Pleistocene, post-Pliocene, or Quaternary Era (as it is variously called), North Africa was united with Spain on the one hand and Sicily on the other.

Dumont represents—in his 'Carte Géologique de l'Europe'—that the strata opposite each other at Capes Spartel and Trafalgar are both of Eocene age, and that at one time they were continuous; consequently the union there was owing to a post-Eocene elevation. It may, however, have been due to a post-Miocene upheaval, as Miocene strata occur in Algeria; whilst the first connection between Asia Minor and N. Africa was probably in the earlier Pliocene times, after which union there must have been a subsidence below the sea-level when the later Pliocene beds which cover half Sicily were deposited; then again the land connection was re-established at the time of the elevation of Etna and Vesuvius, thus forming a migratory line for the fauna of the post-Pliocene period.

Here we see, then, two lines of migration to N. Africa from Europe, the one by way of Spain and Morocco, the other *viâ* Tunis and Sicily.

Geologists usually adopt the following plan of arriving at the land contour of this period, *viz.*, by raising the land bodily 500 fathoms; this would unite North Africa and the Balearic Isles with Spain, Corsica with Tuscany, Tunis with Sicily, and the heel of Italy with European Turkey; it would also convert the Ægean Sea into dry land, and make one great tract of land from Asia Minor to Greece, North Syria being united therewith by way of Cyprus and Crete. The Mediterranean would thus be converted into two great salt-water basins.

* "Geology of Gibraltar," Ramsay & Geike; 'Quart. Journal Geol. Soc.,' p. 505, vol. xxxiv. "Pleistocene Mammalia," Dawkins; Pal. Soc.: 'Cave Hunting,' ch. x.

† Leith Adams, 'Quart. Journal Geol. Soc.,' p. 537, vol. xxxiii.

Mr. Mathews, comparing certain features in the Algerian flora,* informs us that there are in Algeria 272 species of Oriental plants not occurring in Sicily; and he further goes on :— "The question is by what route did they travel between North Africa and the Levant? If we examine the eastern distribution of these species we shall find that many of them occur in Greece, European Turkey, East Germany, South Russia, Asia Minor, and Syria, or some of these countries; others again in Egypt, Arabia-Petræa, and Arabia, the remainder in both these regions. At least half of the 272 species are absent from the southern side of the Levant, and *must have migrated from the north of the Levant and North Africa*, or *vice versâ*. Among the species which have travelled along this line, but have not passed into Europe, one may be particularly mentioned, one of the most interesting in its distribution, as it is one of the noblest of the creations of the vegetable world,—I mean the cedar of Lebanon. This magnificent tree, which unhappily may be said to linger rather than flourish in the Algerian Atlas, is found scattered in scanty patches in several parts of the chain, but nowhere in abundance except at Batna, and in the celebrated forest at Teniet el-Haad. The Atlantic cedar is a distinct variety of the cedar of Lebanon, and has been described under the name *Cedrus atlantica*. The nearest point to North Africa where the cedar is again met with is on the mountains of Cyprus, where it was discovered by Sir Samuel Baker in September, 1879. Sir Joseph Hooker considers the Cyprus cedar another variety of the cedar of Lebanon, and names it var. *brevifolia*. Another cedar nearly allied to the *Cedrus Libani* is the *Cedrus deodara* of the Himalayas. The differences in race in the Algerian, Cyprus, and Lebanon cedars imply a great lapse of time since their habitats were severed.

"One explanation, and one alone, will account for these phenomena of distribution. Sicily, geologically speaking, is of very recent origin. Before its existence the ranges of the Atlas must have extended into Greece. It is not necessary to suppose that the cedar and other species travelled in a direct line between North Africa and Syria,

* 'Flora of Algeria,' p. 30, by Wm. Mathews, M.A., F.R.S.

as they may have radiated into their present habitats from some point further to the north. I incline, nevertheless, to the belief that the Atlantic chain extended from North Africa to the Lebanon, and that the mountains of Crete and Cyprus are surviving fragments of it."

We are thus provided with a land route for migration from Algeria to Malatia.

Now, resuming the thread of our argument, we may assume that a white or yellow *Anthocharis* was generally dispersed in suitable localities over the whole of this area. We may, I think, further assume that the then dominant form was white, and that during the subsequent great secular depression of temperature it was driven to certain isolated points, owing to the great struggle for existence consequent on the migration southward of all life. Then followed the amelioration of temperature, the gradual reflex movement of life, and the subsidence of the Mediterranean area giving Europe her present geography.

It now becomes advantageous, if not absolutely necessary, if the species is to continue to exist, for a hardier form to be produced, and gradually therefore the yellow form is evolved, which in time becomes, as at present, the dominant race, and in the far east (N.W. Punjab) entirely supplants the ancestral stock; though I must here mention that the ♀, being the last to assimilate itself, has scarcely even yet completed its transformation, as it is not uncommon to see an almost white specimen. In Armenia we have apparently the most recent emanation of the yellow form—var. *Mesopotamica*—existing side by side with the whitish *Penia*. But *Penia* itself appears to be in a state of transition, for it is always more or less tinged with sulphur; and this forces the conclusion that *Penia* is in process of change towards the yellow form. Again, *Tomyris* is even more sulphurous than the preceding species, and though very distinct in shape and pattern of wings, inhabiting the mountains of Askhabad without any contact with the yellow group, yet it does not seem improbable that it may be assimilating itself in coloration to the present dominant race.

We now come to the two very distinct species existing side by side in Algeria, viz., *Pechi* and *Charlonia*. It is curious that in this country, which appears to be the

western headquarters of the yellow form, these two distinct species, the white *Pechi* and the yellow *Charlonia*, should obtain. The former, however, is very rare, whilst the latter is common: this shows that the one has not the power of assimilation; consequently selection comes in, keeping the two species distinct, but working to the detriment of the one and to the advantage of the other, so that probably the one is on its way to extinction.

The latest record of *Charlonia* from the Canary Islands is very interesting, but perhaps not surprising. The two specimens sent to the National Collection differ in no way from those taken in Algeria. It is most probable that when Marocco is more explored this species will be found all down the north-west coast of Africa, whence it is easily understood how it found its way across the very narrow strip of intervening ocean.

We may, I think, safely conclude that the present distribution of this little desert group of *Anthocharis* has been brought about in the manner here suggested.

PS.—Since writing the above I have received vol. v. of Romanoff's Memoirs, in which Christoph says that a larger number of *Tomyris* have been received, and that the males are more strongly tinged with yellow than the one figured in vol. i. This supports my view that *Tomyris* may be gradually assimilating its colour to that of the *Charlonia* subsection of this subgroup. Christoph further says that Staudinger considers that *Pechi* is probably a Mauritanian variety of *Tomyris*. With this, however, I cannot agree, as the wings are very different in shape, *Tomyris* having the apex decidedly rounder and wing broader proportionately. Furthermore, the general appearance of the two insects is quite dissimilar, as may be gathered from the foregoing descriptions.